380
CARTILAGE THICKNESS, DENUDED AREAS, AND BONE SIZE IN KNEES PRIOR TO TOTAL KNEE REPLACEMENT (TKR) – DATA FROM THE OSTEOARTHRITIS INITIATIVE

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Purpose: Total knee replacement (TKR) has been proposed to represent an important clinical endpoint in knee OA. Imaging biomarkers capable of predicting relevant clinical endpoints may be valuable surrogate markers for testing the efficacy of DMOADs in clinical trials. The purpose of this study was thus to determine whether knees receiving a TKR show differences in (subregional) cartilage thickness, denuded subchondral bone areas (dABs), and subchondral bone size (tABs) compared with control knees from matched controls who did not receive a TKR.
Methods: Knees from OAI participants who received a TKR between baseline and 48 month follow-up were studied. These were compared with control knees with the same KL grade (central X-ray readings strata 0–1, 2, 3, 4) from OAI participants with the same sex and age within 5 years who did not receive a TKR during this period. Quantitative cartilage measures were obtained from sagittal DESSwe images acquired at 3 Tesla in the OAI. The time point prior to the advent of the TKR (≤1 year) was used; segmentation of weight-bearing femorotibial cartilage was performed by 12 readers using Chondrometrics software (Chondrometrics GmbH, Ainring, Germany). A cross-sectional comparison between TKR cases and control knees was carried out using a paired t-test with adjustment for multiple comparisons (n = 16, 4 cartilage plates and 4 parameters per knee). A p-value of <0.0031 (0.05/16) was considered significant (#) and a p-value of <0.05 considered borderline significant (§).
Results: 191 knees of 165 OAI participants received a TKR, of whom 155 had an MRI at the visit prior to surgery. Of these, 74 knees (25 men, 49 women, age 45 to 78 yrs, BMI 21.2 to 41.8, 5 KLG0/1, 20 KLG2, 44 KLG3, and 2 KLG4) could be adequately matched with 74 control knees (no TKR).
Cartilage thickness not including denuded areas (ThCcAB) did not differ significantly between TKR cases and controls. However, denuded areas (dABs) were significantly larger (Table), and cartilage thickness including denuded areas (ThCtAB) was significantly smaller in the medial femorotibial compartment of the TKR cases than in control knees ($p < 0.01$). On a subregional level, the largest differences in ThCtAB were observed in the external subregion of the medial tibia and in the external and central subregions of the medial femur (−27 to −28%; all $p < 0.001$). tABs tended to be larger in cases than in controls, but the difference only reached borderline significance in the medial tibia (+6.3%; $p = 0.006$; Table).

Table: Denuded (dAB) and total (tAB) subchondral bone area in knees prior to TKR and controls

	TKR cases (n = 74)		Controls (n = 74)		Difference	
	Mean	SD	Mean	SD	%	p-value
dAB (%)						
Medial tibia	11.9	15.3	3.5	7.2	239	<0.0001#
Medial femur	23.5	27.3	7.2	14.5	226	<0.0001#
Lateral tibia	9.1	16.5	4.6	9.6	97	0.06
Lateral femur	7.4	14.1	3.6	7.8	105	0.06
tAB (cm^2)						
Medial tibia	11.2	2.2	10.6	1.9	6.4	0.0061§
Medial femur	7.8	1.5	7.5	1.5	3.5	0.19
Lateral tibia	10.4	1.9	10.0	1.9	3.7	0.11
Lateral femur	8.0	1.7	7.8	1.4	2.1	0.44

#$p < 0.0031$; §$p < 0.05$.

Conclusions: OA knees displayed greater dABs at the time point prior to TKR compared with matched controls (without TKR), with differences being most prominent in the medial femorotibial compartment (specifically in its external and central subregions). Further studies should explore whether longitudinal changes in quantitative cartilage parameters prior to TKR differ between cases and controls, and may predict time to TKR.

381
ASSESSMENT OF CARTILAGE USING T2 MAPPING IN PATIENTS WITH ANTERIOR CRUCIATE LIGAMENT RUPTURE

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Purpose: Anterior cruciate ligament (ACL) rupture has been associated with early occurrence of osteoarthritis (OA), which was believed to be due to instability derived from ACL insufficiency. However, recent studies showed more than half of the patients who had ACL reconstruction will develop OA changes within 10 years after an ACL rupture. These findings suggest that the initial injury to the articular cartilage and subchondral bone may also play a role in the development of OA. On the other hand, the relationship between acute ACL rupture and cartilage injury has not been well documented. One of the reasons for the little understandings in the relationship between ACL rupture and cartilage injury has been that the there was no effective and non-invasive evaluation method of cartilage injury. Transverse relaxation time (T2) mapping is a magnetic resonance (MR) imaging technique that has the potential to quantitatively evaluate deterioration of molecular composition and structural integrity of articular cartilage2). The aim of this study is to evaluate the relation between acute ACL rupture and cartilage injury by using T2 mapping. We especially focused on the relationship between the bone bruise and cartilage injury.
Methods: Fifty five knees of 70 patients (28 women and 42 men, mean age 27.1±4.8 years) with acute ACL rupture were studied with an MR imaging system at 1.5 Tesla (Signa, GE Medical Systems, Milwaukee, WI). Fat-suppressed T2 weighted imaging and T2 mapping in the coronal plane were performed, and T2 value of the cartilage at medial and lateral condyle was measured. For the comparison of T2 value, 40 knees of 20 healthy volunteers (16 males, 4 females, mean age 34.9±6.2 years) without symptoms of knee pain or previous medical treatment concerning knee trauma underwent T2 mapping as the same manner. To evaluate the relationship between acute ACL rupture with or without bone bruise and cartilage injury, T2 value of cartilage at medial and lateral condyle and mean value of entire cartilage at femoral condyle of healthy volunteer were measured. Then each T2 value of cartilage at medial and lateral condyle of the patients without bone bruise and affected and unaffected condyle of the patients with bone bruise were compared. In 48 patients, operative findings of cartilage at the time of surgery were evaluated and compared with the MRI findings. Unpaired and paired T-test was used for statistical evaluation, and statistical significance was defined as $p < 0.05$.
Results: Of the 70 patients, 33 had a bone bruise at lateral femoral condyle. Within the patients without bone bruise, T2 values of cartilage at medial and lateral condyle were 31.5 ms and 33.2 ms. T2 values of cartilage at medial and lateral condyle within the patients with bone bruise were 32.2 ms and 38.3 ms. T2 values of the cartilage overlying bone bruise were significantly higher than that in healthy volunteer and unaffected condyle. T2 values of cartilage at medial and lateral condyle within healthy volunteer were 31.1±4.4 ms and 32.3±3.7 ms, mean 31.6±4.1. T2 values of cartilage at medial and lateral condyle within patients without bone bruise were 31.5±2.3 ms and 33.1±3.1 ms and were not significant to that in healthy volunteers. The operative findings of cartilage were well correlate with the MRI findings.
Conclusions: In this study, a significant increase in the T2 of cartilage at the femoral condyle with bone bruise was observed. On the other hand, no significant increase in the T2 of cartilage at the femoral condyle without bone bruise was observed. Thus the presence of bone bruise at the femoral condyle after acute ACL rupture was thought to indicate the presence of cartilage deterioration at that site. Deterioration of articular